Revista Brasileira de Nutrição Esportiva
ISSN 1981-9927 *versão eletrônica*

Periódico do Instituto Brasileiro de Pesquisa e Ensino em Fisiologia do Exercício

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OVERCOMPENSATION OF CARBOHYDRATES IN FUNCTIONAL ASSESSMENT IN ATHLETES SPRINTERS

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ABSTRACT

Overcompensation of carbohydrates is an efficient method to make the tissue energy reserves, making this an ergogenic effect. This effect is widely studied and proven only in long-term performance. This study aimed to investigate the influence of overcompensation of carbohydrates in the functional assessment in athletes sprinters. The sample was composed of nine sprinters at the age between 19 to 39 years, Fortaleza-CE. This research took place at a clinic specializing in sports health. Anthropometric measurements were collected and made a food history. After that, the sprinters were subjected to a normal caloric diet for six days and then carried out the effort test. After the test, the athletes remained consuming this diet for three weeks, where they started the overcompensation protocol for six days and after, subject again to the effort test. Blood samples were collected before and after the tests to check blood glucose. The results showed that although there were no significant differences in running time, effort test, cardiopulmonary fitness and blood glucose, there was a significant increase in aerobic capacity suggesting that the applied protocol can improve sports performance. We conclude that in a short-term exercise the overcompensation of carbohydrates can be an efficient ergogenic strategy.

Key words: Diet. Carbohydrate loading. Blood glucose. Anaerobic threshold.

RESUMO

Supercompensação de carboidratos na avaliação funcional e no desempenho de atletas velocistas

A supercompensação de carboidratos é um método eficiente para aumentar as reservas energéticas nos tecidos, este efeito já é amplamente estudado e comprovado no desempenho em exercícios de longa duração. Este estudo teve como objetivo investigar a influência da supercompensação de carboidratos na avaliação funcional em atletas com exercício de curta duração. A pesquisa foi realizada em uma clínica especializada em saúde esportiva e a amostra foi composta por nove velocistas com idade entre 19 e 39 anos. Foram coletadas medidas antropométricas e a história alimentar. Depois disso, os velocistas foram submetidos a uma dieta normocalórica por seis dias. No dia seguinte realizaram o teste de esforço. Após o teste, os atletas permaneceram consumindo essa dieta por três semanas, onde iniciaram o protocolo de supercompensação por seis dias e foram submetidos novamente ao teste de esforço. Amostras de sangue foram coletadas antes e após os testes para verificar a glicose no sangue. Os resultados mostraram que apesar não haver diferenças significativas no tempo de corrida, na taxa de força, na aptidão cardiorrespiratória e na glicemia, houve um aumento significativo da capacidade aeróbica sugerindo que o protocolo aplicado pode melhorar o desempenho esportivo. Concluímos que em exercício de curta duração a supercompesação de carboidratos pode ser uma estratégia ergogênica eficiente.

Palavras-chave: Dieta da Carga de Carboidratos. Glicemia. Limiar anaeróbio.

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Revista Brasileira de Nutrição Esportiva
ISSN 1981-9927 versão eletrônica

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INTRODUCTION

Since the 1970s, due to the technological evolution that facilitated the analysis of gases, the use of cardio-respiratory tests was highlighted in the research area, as well as in the clinical area. By analyzing the behavior of oxygen consumption (VO_2), and other variables, one can obtain and use information of great importance. To assess VO_2, the ergospirometric test examines the electrical activity of the heart and its clinical repercussions, assessing the adequacy between the demand and supply of oxygen (O_2) to the myocardium (Neto and contributors, 2001).

This test, called cardiopulmonary or cardio-respiratory, or ergospirometric, actually carries information about the integrity of all the systems involved in the transport of gases, that is, it involves not only the cardiovascular and respiratory, but also neurological, humoral and hematological (Neto and contributors, 2001).

Basically, the function of the cardiovascular and pulmonary systems is to maintain the cellular respiration and nutrition process, and one way of assessing this function is through the analysis of VO_2 and the production of carbon dioxide (VCO_2), which in turn vary with therefore, the use of a cardiopulmonary exercise test in which VO_2 and VCO_2 can be determined directly, ultimately reflects the integrity of these systems as well as their adaptations during exercise (Neto and contributors, 2001).

In the search for optimization of sports performance, several methods have been used in several areas of knowledge. These helplines have been conventionally called ergogenic resources. Ergogenic is any substance or phenomenon capable of improving work or performance, from an improvement in strength, speed, response time, or resistance of an athlete (Wilmore and Costil, 2001).

The ergogenics can be divided into five categories: biomechanical, psychological, physiological, pharmacological and nutritional. In the category of nutritional ergogenics, the glycogen overload method results from a dietary or exercise-diet procedure that elevates muscle glycogen stores to concentrations two to three times above normal (Foss and Keteyian, 2000).

To date, few studies have been conducted to determine whether carbohydrate intake leads to improved performance (glycemic profile, aerobic capacity, and anaerobic threshold) during high-intensity and short-term exercise (less than one hour).

This study provides a research of aerobic capacity during short-term exercise and the impact of nutritional strategies to modulate plasmatic glucose and subsequent repletion.

MATERIALS AND METHODS

Type of study

The research is descriptive and experimental on the effects of carbohydrate overcompensation on sprinters in the cardiopulmonary exercise test.

Population and Sample

Nine sprinters of both sexes, 44.44% (n = 4) female and 55.55% (n = 5) males, aged 19 to 39 years, participated in the study.

Individuals who presented normal clinical status after anamnesis performed by a professional specialized in sports medicine, as well as biochemical conditions that allow methodological applicability (blood glucose, blood pressure, heart rate, ventilatory mechanics, locomotor system, neurological system, etc.) were included within the limit of normality and / or that do not generate risk or compromise to the physical integrity of the evaluated individuals, before the beginning of the ergospirometric evaluation.

The individuals who had some metabolic alteration (Diabetes Mellitus I and II, arterial hypertension, heart failure, heart disease, coarctation of the aorta, peripheral vasculopathy, etc.) were excluded, which causes some harm in the applied methodology or induces the risk in test of maximum effort.

Location and period

The test was performed in a Force Laboratory of a clinic specialized in sports health, located in the city of Fortaleza.

Study variables

According to the questions investigated, the dependent variables of this study were the time of the test, VO2max and the anaerobic threshold and the blood glucose levels.

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Experimental design

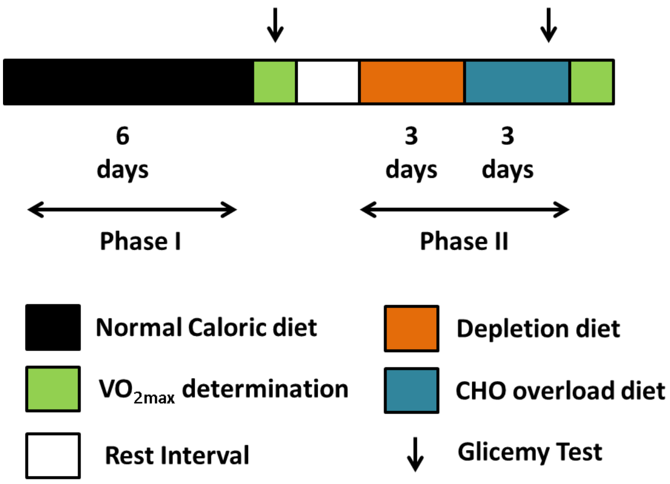

Figure 1 - Representation of the experimental model applied in sprinters athletes. VO2max: Maximal oxygen uptake. CHO: carbohydrate.

The work was divided into two phases, which were adapted from the overcompensation protocol (McArdle, Katch and Katch, 2003). The athletes participated in the cardiopulmonary exercise test with an apparatus called ergospirometer. The Harbor Protocol was used. This protocol was adjusted according to the individual's physical profile. Relative air humidity, ambient temperature (ºC) and barometric pressure were measured at the evaluation site.

In addition, the test was accompanied by a doctor specialized in sports medicine, who was equipped with equipment, in case of sinister during the applicability of the test. At the beginning and after the exercise test the blood glucose was measured and during the test the anaerobic threshold was used to verify the influence of both measures on the athlete's performance. The anaerobic threshold was measured by the ergospirometer apparatus through the value of O_2 and CO_2 during the test.

Phase I

Athletes received a normal caloric diet (60% carbohydrate, 15-20% protein and less than 25% lipid) with micronutrients adequate (100% of the DRI recommendations - Dietary Reference Intakes, National Institute of Health) to consume for six consecutive days. On the seventh day, they participated in the cardiopulmonary exercise test. At the beginning and after the exercise test the blood glucose was measured. The athletes maintained the consumption of the normal caloric diet for 3 weeks.

Phase II

After 3 weeks, the athletes spent three days on a depletion diet (40% carbohydrates, 30 to 35% proteins and 25 to 30% of lipid of the total calories). The diet was enriched with a protein supplement in order to reach the percentage of protein. Over the next three days, the athletes consumed a diet of overload (carbohydrates: 70%, 1.8 g of protein). On the seventh day, athletes were again submitted to cardiopulmonary exercise test.

Statistical analysis

The data treatment (before and after the overcompensation of carbohydrates) was performed through descriptive statistics, using Student's t-test for dependent variables, by matching the data, with the Software Prism package. It was adopted $p < 0.05$ as a minimum level of significance. All data were reported as mean ± standard deviation.

Ethical aspects

The research was submitted and approved under unnumbered opinion on August 17, 2004 by Profa. Dra. Maria Salete Bessa Jorge, President of the Research Ethics Committee of the State University of Ceará with title “Glycemic profile and lactate threshold in sprinklers with carbohydrate overcompensation”. A clarification and explanatory work was carried out on the evaluation procedure, as well as the benefits and precautions to be observed, to avoid any harm to the integrity of the athletes. All individuals who participated in the study signed an informed consent form.

RESULTS

Effort Test Time

In Figure 2, it can be observed that the duration of the test in Phase II, after overcompensation, increases with respect to Phase II, however without significant difference (*p = 0.2953).

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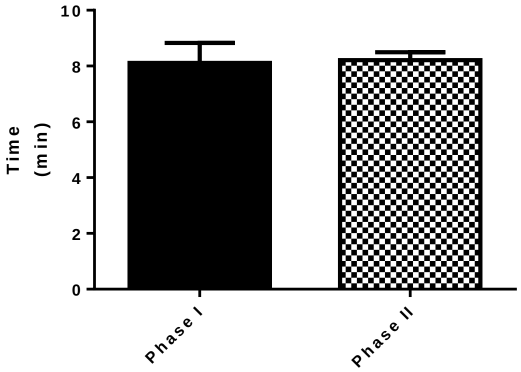

Figure 2 - Evaluation of the Effort Test Time applied in athletes. Data are means 95% confidence interval (8.11 + 0.71, 8.20 + 0.28). t test, *p> 0.05. Phase I: pre-overcompensation of carbohydrates; Phase II: post-overcompensation of carbohydrates.

Cardiopulmonary Fitness

In Figure 3, it can be observed that in Phase II, there was an increase in the cardiorespiratory fitness, however without significant difference between excellent (p = 0.2511) and good (p = 0.1547) groups.

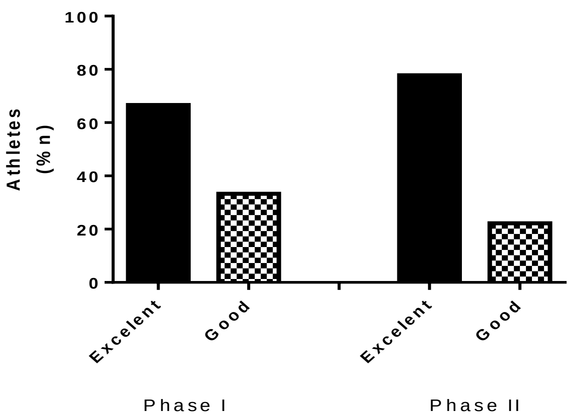

Figure 3 - Evaluation of the Cardiopulmonary Fitness at Effort Test applied in athletes. Data are means 95% confidence interval. Phase I: pre-overcompensation of carbohydrates; Phase II: post-overcompensation of carbohydrates.

Power Rating

In Figure 4, it can be observed that the Potency (W) in Phase II, after overcompensation, decreases in relation to Phase II, however without significant difference (*p = 0.4716).

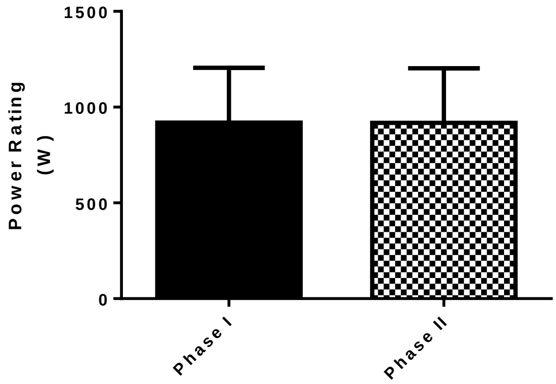

Figure 4 - Evaluation of the Power Rating (W) at Effort Test applied to athletes. Data are means 95% confidence interval (919.5 + 286; 917.7 + 285.8). t test, *p> 0.05. Phase I: pre-overcompensation of carbohydrates; Phase II: post-overcompensation of carbohydrates.

Aerobic Capacity

In figure 5, it was observed that there was a significant increase in VO2max in Phase II (*p = 0.06265), after overcompensation, in relation to Phase I.

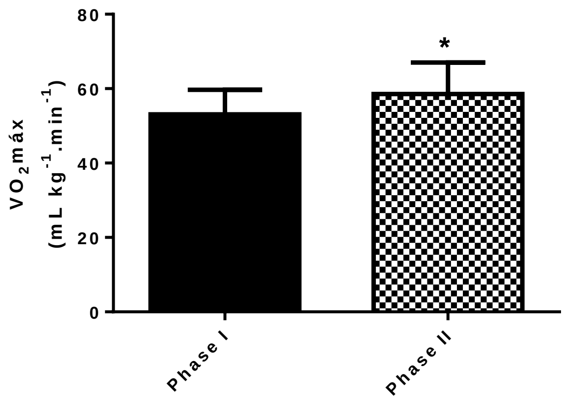

Figure 5 - Evaluation of VO2max (mL / kg-1.min-1) at Effort Test applied to athletes. Data are means 95% confidence interval (53.7 + 6.61; 58.59 + 8.44). t test, *p < 0,05. Phase I: pre-overcompensation of carbohydrates; Phase II: post-overcompensation of carbohydrates.

Glicemy

Figure 6 shows an increase in blood glucose in Phase II, after overcompensation, in relation to Phase I, but without significant difference (*p = 0,2265).

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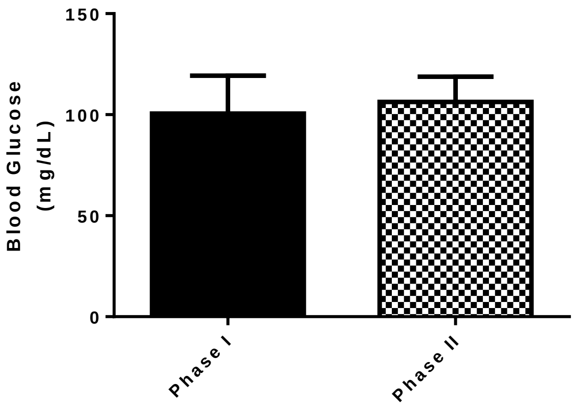

Figure 6 - Evaluation of plasma glucose (mg/dL) at Effort Test applied to athletes. Data are means 95% confidence interval (100.6 + 18.74; 106.3 + 12.46). t test, *p > 0,05. Phase I: pre-overcompensation of carbohydrates; Phase II: post-overcompensation of carbohydrates.

DISCUSSION

The improvement in short-term exercise performance with carbohydrate intake is not well understood, but it is known that nutrition is one of the factors that optimizes athletic performance by reducing fatigue, allowing the athlete to train for longer, or even to recover faster between exercise sections (Aoki and Seelaender, 1999; Liebman and Wilkinson, 2002; McMurray and Anderson, 2002).

Figure 1 shows that carbohydrate overcompensation improved the duration of the exercise test, even without significant difference.

According to Guyton and Hall (2002), Bowtell and contributors (2000), Marques and Tirapegui (2000), Liebman and Wilkinson (2002), Lima and contributors (2003), the depletion of muscle glycogen and the low caloric intake of the diet is invariably associated with reduction in exercise and eventual interruption of strenuous exercise caused by muscle fatigue, resulting from a decrease in energy reserves during exercise.

Cardiopulmonary fitness is determined by physical conditioning, which is a process in which the individual is imposed on certain organic, morphological and functional conditions through training and physical exercise (Godoy, 1993).

In this work, it is observed that there is an improvement in sports performance after the overcompensation of carbohydrates, so that the number of athletes with excellent cardiopulmonary fitness increased.

According to Powers and Howley (2000), the inability to maintain power or strength production during repeated muscle contractions generates fatigue and consequently interruption of work. Although we verified in this work, that the production of power decreased during the east of effort, there were no direct implications in detriment of the sport performance.

VO2max is determined by the ability to increase cardiac output and direct blood flow to working muscles, so it is considered the most valid measure of cardiovascular fitness used as an index of physical fitness (Neto and contributors, 2001; Powers and Howley, 2000; Tebexreni and contributors, 2001).

The respiratory capacity increased significantly (p <0.05) in the exercise test after carbohydrate overcompensation (Figure 5), suggesting that this dietary protocol may be efficient in short-term exercise. These results corroborate the data of Arkinstall and contributors (2001), in which plasma glucose increases after 10 minutes of exercise in running and cycling athletes when supplemented with carbohydrates. In the Angus and contributors (2002) tests, plasma glucose increased after 30 minutes of exercise.

In the experiments of Arkinstall and contributors (2001), in which subjects underwent heavy exercise 24 hours before each test and consumed three meals totaling 45kcal/kg of body weight (carbohydrate: ~ 24kcal/kg, lipid: ~ 15kcal/kg, protein: ~ 6 kcal/kg), plasma glucose was elevated at the beginning of the exercise when supplemented with carbohydrate, differently from that shown in figure 6, which shows elevation, without significant difference after carbohydrate overcompensation.

This increase in glycemia after physical activity may be due to the fact that insulin and glucagon are regulated more by sympathetic activity during exercise than by plasma glucose, and the blood glucose concentration may not change or even increase in the first hour of exercise (Liebman and Wilkinson, 2002).

At the beginning of the exercise, muscle glycogen declines rapidly, so the muscle uptake of circulating blood glucose increases markedly during the initial stage of exercise and continues to increase with subsequent exercise, while total carbohydrate

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oxidation remains constant or decreases (Liebman and Wilkinson, 2002; McArdle and contributors 2003).

In the experiments by Angus and contributors (2002), carbohydrate oxidation did not change significantly during exercise, although fatigue values tended to be lower ($p = 0.069$) than those observed in the 30 minutes. In the results of Arkinstall and contributors (2001), there was a significant difference in plasma glucose oxidation with carbohydrate intake in running and cycling exercises. During the run, plasma glucose concentration rose significantly above resting values after 10 and 30 minutes of exercise with carbohydrate and water intake and remained elevated up to 50 minutes of exercise by both treatment conditions.

Like this study, Ferreira and contributors (2016), observed that exercise tolerance was significantly higher when using carbohydrate diets, thus inducing a higher VO2max during exercise as well as after exercise. According to Lima and contributors (2003), there is no doubt that the overcompensation of carbohydrates is an efficient method to make tissue energy reserves available, making it an ergogenic effect. However, in most studies, this effect is widely studied and proven only in performance of long-term exercise, such as distance runners.

But, according to Powers and Howley (2000), the carbohydrate intake improved by 6.5% in exercise with cycle ergometer lasting sixty minutes to 80% of maximal oxygen consumption (VO_2max). Another study (with weight training) demonstrated, for example, that individuals consuming a carbohydrate beverage (10% glucose polymer) performed more series and repetitions compared to those who ingested a placebo solution (Bacurau, 2001).

CONCLUSION

We concluded that in this study, only the VO_2max increased significantly after the overcompensation of carbohydrates in the athletes, suggesting a favorable result related to the increase in aerobic capacity and, therefore, the sport performance in short duration and high intensity exercises.

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ISSN 1981-9927 ***versão eletrônica***

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Recebido para publicação em 16/10/2018
Aceito em 20/01/2019